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QUARTERLY PROGRESS REPORT

December 27-March 27, 1967

The previous progress report described the preliminary results from the D-Region Ionospheric Probe launching (NASA Nike-Cajun 10.181). This report describes in detail the experiments and the various payload sub-systems. Figure 1 is a schematic drawing showing the lay-out of the experiments and other packages in the payload. Figure 2 is a block diagram indicating the electrical connections between the various sub-systems.

The D-Region Ionospheric Probe is a multiple experiment electronics package which has been designed to make a number of measurements in the D-region of the ionosphere. These measurements include: positive and negative ion densities, Lyman alpha radiation, electron density, and radiation at 1.27μ by $O^2(a^1\Delta_g)$ molecules. The package is designed to fit onto a Cajun sustainer motor. It is composed of three main sections: the forward section contains aspect sensors, Gerdien condensers along with a Lyman alpha sensor and associated electrometer circuitry, and a radiometer; the center section contains a VLF receiver, two CW receivers used in a Faraday Rotation experiment and their antennas, and a high-frequency capacitance experiment, the rear section contains a standard Nike-Cajun telemetry package, a very accurate voltage regulator for calibration purposes, and a "G" timer and arming circuit for mechanical systems actuation.

The experiments in the forward and rear sections are housed in an aluminum skin whereas those in the center section are housed in a fiberglass skin. All three sections of skin also serve as package structure. Enclosure of the VLF and propagation receiver antennas within the structure of the package necessitated the use of a fiberglass skin section.

In the forward section of the rocket there are two mechanical systems which operate during the early stages of the flight. The first of these consists of a mirror mounted on a sliding platform which is pushed out the side of the forward section at t+35 seconds. This mirror allows the radiometer to look forward along the side of the rocket; it is housed within a light-tight pipe and looks forward through a quartz window. The light-tight pipe eliminates the effects of scattered light from the side of the rocket and from the sun. The second mechanical system consists of a pair of clam shells which are discarded at t+45 seconds. During the early stages of the flight the clam shells are held in place by a single shear-bolt. At a time determined by the "G" timer this bolt is cut with a pyrotechnic bolt cutter, and the clam shells are pushed apart and away from the rocket by several springs, thus exposing the Gerdien condensers to the plasma.

The third mechanical system is located in the center section of the package and consists of two helical spring antennas which are released when a pyrotechnic retractor is fired by the "G" timer. These antennas are used as a probe by the high frequency capacitance experiment.

In order to minimize interference between experiments, the electronics package for each is mounted in its own metal container. These metal containers are either attached to the skin of the package or are built into the coupling rings which hold the three separate sections of package skin together. This system of individual packaging, while cutting down on electrical interference and tending to strengthen the structure of the package, adds measurably to its weight and wastes some volume within it.

As previously mentioned, two Gerdien condensers are mounted ahead of the forward section under the clam shells. These instruments are cylindrical aluminum tubes, each enclosing a tapered probe. Both ends of each tube are covered by a fine tungsten grid which prevents fields within each tube from fringing to its outer surface. By connecting the probe to the input of an operational amplifier, it is maintained at rocket body potential. The inner surface of each cylinder is maintained either at a positive voltage of +12 volts in the case of the I+ condenser or a negative voltage of -12 volts in the case of the I- condenser. The outer surface and the screening grids of the tubes are maintained at ground potential. This biasing technique causes particles entering with a charge of the same polarity as that of bias voltage to be forced toward the probe upon entering the tube. Particles of the opposite polarity are collected on the inner surface of the condenser. The probe for the magnetic aspect sensor is mounted between the condensers.

Immediately behind the condensers, within the skin of the forward section of the package are mounted: the electronics package for the magnetometer, the solar aspect sensor, and the Lyman alpha ionization chamber. The output from this ionization chamber, and the currents being collected from the Gerdien condensers are fed into high gain d-c operational amplifiers with input impedances on the order of ten kilomegohms. The output of these amplifiers is connected directly to the inputs of IRIG subcarrier oscillators. In addition to these amplifiers the electrometer amplifier package contains two dc to dc converters and switching circuitry which generates a voltage sweep approximately once every minute and connects it to the input of the amplifiers for inflight calibrations. This sweep is also connected to a commutator channel where its amplitude is monitored. The electrometer amplifiers have an automatic ranging capability which causes them to change scale before saturating. The scale position of each amplifier is continuously monitored by the one commutator channel.

Mounted immediately behind the electrometer amplifier package is a radiometer which is sensitive to radiation at 127μ and measures $O^2(a^1\Delta_g)$ molecule radiation. This device was purchased as an integral experiment from the Utah State University. Its output is connected directly to the input of one IRIG subcarrier oscillator channel. The radiometer also has an internally mounted thermistor which is monitored continuously by one commutator channel.

In the coupling ring between the forward and center sections of the package are mounted a VLF receiver and a dc to dc converter. The converter supplies ± 12 volts to the VLF receiver and to the two Faraday Rotation CW receivers.

The VLF receiver is a high gain, high input impedance audio-frequency receiver designed to detect the amplitude and phase of a signal broadcast by WWVL in Ft. Collins, Colorado. The phase output of the receiver which is a 20 kc signal modulates the telemetry transmitter directly while the automatic gain control of the receiver is connected to one IRIG subcarrier oscillator.

Immediately behind the coupling ring and connected to it is a can containing both Faraday Rotation CW receivers. These are superhetrodyne receivers for detecting cw signals at 2.23 mc and 3.23 mc. The signals which are radiated from dipole antennas on the ground are modulated by the rocket spin, and phase variations in the resulting nulls are used to calculate electron densities. Below the receiver can encapsulated in a potting foam are the antennas for these receivers as well as the VLF antenna. These antennas consist of ferrite rods wound with a winding tuned at the frequency of their respective receivers.

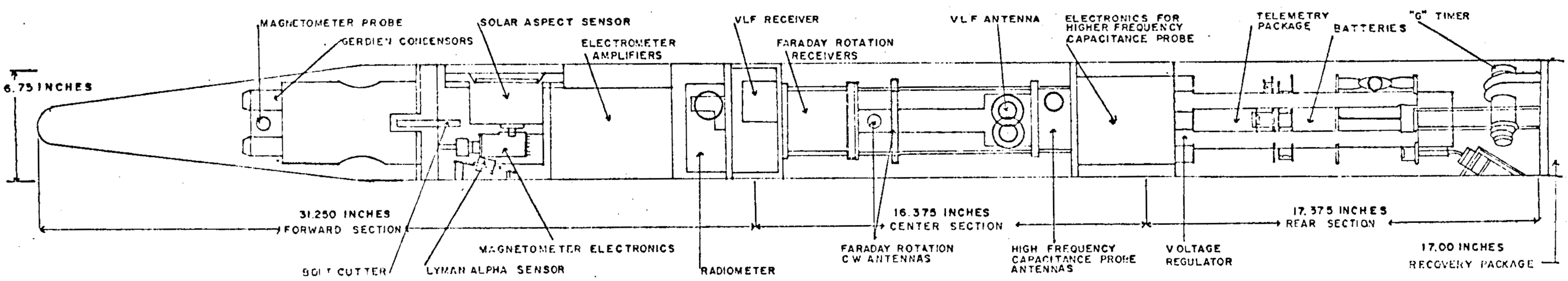
The electronics package for the high frequency capacitance experiment is located in the coupling ring between the center and rear sections. It is sealed in a pressure package which is an integral part of the coupling ring. On top of the ring are mounted two helical spring antennas which deploy rapidly at right angles to the skin of the rocket. The high frequency capacitance experiment measures the permittivity of the plasma at several discrete frequencies.

Immediately behind this rear coupling ring is located a standard NASA telemetry package for Cajun and Apache rockets. Located on the top shelf of the telemetry section is a regulated voltage supply which provides 0, 2.5, and 5 volt reference signals to three commutator segments. Behind the telemetry package there are four silver cadmium batteries which supply firing current, to the pyrotechnic circuits, and a "G" timer which provides timing for clamshell deployment, mirror deployment and antenna deployment. When the "G" timer cam is in the proper position, it closes a relay in the firing circuit of one of these mechanical systems. This relay closure connects a pyrotechnic device to the current source batteries causing the pyrotechnic device to fire. The pyrotechnic devices for the mirror and antennas are retractors which pull retaining pins and allow either the spring antennas to move outward or the mirror mount platform to be pushed out the side of the skin by a spring. Incorporated with the "G" timer is an arming relay of the latching type which connects the current source batteries to the various pyrotechnic firing relays. It is necessary that this relay be in the arm position prior to launch. Indication of the position of this relay is available through the umbilical at the control console in the block house.

The entire instrument package as described above is mounted on a Nike Cajun recovery package.

All of the experiment packages were built at I.T.S.A. with the exception of the radiometer. Goddard Space Flight Center provided the TM package, the recovery package, and the solar aspect sensor. The Research Foundation of the Oklahoma State University assisted with the mechanical and electrical lay-out and integration of the payload.

D-REGION IONOSPHERIC PROBE EXPERIMENT PACKAGE



INTERCONNECTION BLOCK DIAGRAM, D-REGION IONOSPHERIC PROBE